United States Department of Agriculture | Forest Service | Northeastern Area State & Private Forestry | 180 Canfield Street Morgantown, WV 26505-3101

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Date: December 11, 1996

Mr. Jose Cisneros, Superintendent
USDI National Park Service
Gettysburg National Military Park
Gettysburg, PA 17325

Dear Mr. Cisneros:

The enclosed report documents the biological evaluation and the post-suppression summary of hemlock woolly adelgid in the National Cemetery at Gettysburg National Military Park.

In brief, the treatment conducted last spring did prevent the hemlock woolly adlegid (HWA) from increasing but residual populations are still a concern. Because HWA has two generations per year and is parthenogenetic (all female population), the reproduction rate is very high and the existing population is likely to rebound rapidly if left untreated. We recommend the infested trees be treated again as soon as possible followed by an additional spring treatment if necessary.

I will continue to work with Randy Krichten of your staff to follow up on the recommended treatments as necessary.

If you have any questions regarding this report or require further information, please call me at (304) 285-1546.

Sincerely,

BRADLEY P. ONKEN
Entomologist
Forest Health Protection

Enclosures

cc: Noel Schneeberger, AO
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BIOLOGICAL EVALUATION AND POST-SUPPRESSION SUMMARY OF THE HEMLOCK WOOLLY ADELGID, *ADELGES TSUGAE* (ANNAND) IN THE NATIONAL CEMETARY, GETTYSBURG NATIONAL MILITARY PARK - 1996

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ABSTRACT

The hemlock woolly adelgid, Adelges tsugae (Annand), was first observed in the National Cemetery at Gettysburg National Military Park in the winter of 1994. A treatment of horticultural oil was applied to the infested trees in the spring of 1995 and again in April of 1996. Although existing populations of the adelgid are relatively low, densities are expected to increase rapidly and further treatment of the infested trees is recommended.

INTRODUCTION

The National Cemetery at Gettysburg National Military Park contains a variety of ornamental tree specimens and includes the eastern hemlock Tsugae canadensis (L) Carriere. In addition to aesthetics, many of these trees have historical significance dating back to the dedication of the Cemetery during the Civil War.

The hemlock woolly adelgid, Adelges tsugae (Annand), was first discovered in the Cemetery in the winter of 1994. Initially, populations were relatively low and found to be scattered among the 28 hemlock specimens. The infested trees were treated in the spring of 1995 with a 1 percent solution of horticultural oil. A subsequent survey in February, 1996 found a substantial increase in hemlock woolly adelgid (HWA) populations from the previous year and the infestation had spread to all hemlocks within the Cemetery. Consequently, the infested trees were treated with a 2 percent solution of horticultural oil in April 1996.

Post-treatment surveys conducted in October, 1996 indicated that the treatment reduced HWA densities on the majority of the trees, but because the HWA is parthenogenetic and has two generations per year, residual populations remain sufficient to rebound rapidly. Consequently, further treatment is recommended.

TECHNICAL INFORMATION AND BACKGROUND

The origin of this exotic pest is suspected to be eastern Asia. Here, innocuous populations of HWA cause little impact or mortality to Asian hemlock species (McClure, 1987). HWA was first reported in the western United States in the 1920's and in the East in 1953 near Richmond, Virginia. In the West, the HWA does not appear to be a significant forest pest, but rather seems to maintain similar levels as in Asia (McClure, 1987). The reason for this is not fully understood but tree resistance of western hemlock species is suspected (McClure, 1995). Up until recently, the HWA was only a problem in the ornamental landscape in the East. In the past decade however, forest health specialists have reported infestations from North Carolina to Massachusetts and extensive tree mortality has now occurred in the hemlock forests of Virginia, Pennsylvania, New Jersey, New York and Connecticut.

HWA completes two parthenogenetic (asexual) generations per year on hemlock (McClure, 1987). During early spring (March-April), overwintering adults lay eggs which hatch in several weeks in April and May. The emerging nymphs called crawlers, settle on the twigs at the base of needles and begin to feed and develop through maturity which includes four nymphal stages and the adult female. This spring generation matures my mid-June. About 50 percent of these adults produce wings and disperse in search of a spruce host. No suitable spruce host exists in North America so these winged adults consequently die (McClure, 1987). The other 50 percent are wingless and remain on hemlock where they reproduce. Eggs of this overwintering generation hatch by early July and the crawlers settle on the new growth and enter an aestivation period that lasts until October when feeding and development resumes throughout the winter months.

Although the HWA is very small and difficult to see without the aid of a hand lens, the adelgid produces a white woolly substance as it matures and resembles the tip of a cotton swab. These woolly masses are the most conspicuous during the spring when egg clusters are present (McClure, 1995). The adult females lay eggs under these woolly masses which protect the eggs from predation and prevents dislodgement.

The HWA prefers to feed on the youngest twig growth available. Crawlers of the first generation (spring generation) settle on twigs produced during the previous season while crawlers of the second generation (overwintering generation) will normally seek out the current year growth. In the East, both eastern and Carolina (T. caroliniana) hemlocks are susceptible hosts. Feeding is performed by the insertion of its stylet bundle (piercing sucking mouthparts) which penetrates the plant tissue to the feeding site, the xylem ray parenchyma cells. These cells are responsible for nutrient storage and transfer in the plant (Shields, 1996).

Damage to the tree as a result of heavy feeding is usually expressed by desiccating needles that turn a grayish-green color prior to dropping from the infested branches. Twig buds are often killed preventing new growth and dieback of major limbs follows within several years, most often from the bottom of the tree upwards (McClure, 1996). Trees stressed by other biotic or abiotic factors will often die within a few years. Trees that manage to survive longer are in a severely weakened state and highly susceptible to drought and secondary insect and disease organisms such as the hemlock borer Melanophila fulvoguttata (Harris) or the root-rot fungi, Armillaria mellea.

Dispersal of the HWA is during the crawler stage and movement between trees is primarily the result of wind, birds and other wildlife. Because HWA is parthenogenetic and has two generations each year, its population is capable of increasing rapidly on healthy hemlocks (McClure, 1995). Careful inspection and monitoring is an important aspect of controlling HWA prior to the occurrence of damage to the trees.

The objective of this report is to present biological data that will show the current status of the infestation, evaluate the treatment conducted last spring and provide future treatment recommendations.

METHOD

In February 1996, pre-treatment HWA survey was conducted in the National Cemetery at Gettysburg National Military Park. A cursory inspection of all hemlocks was first conducted to determine the presence or absence of HWA and to select individual infested trees to monitor. Of the 28 hemlocks within the Cemetery, 11 trees were selected based on access to lower limbs and the presence of HWA. At each sample tree a branch was selected from each cardinal direction. From each of the four branches, a six-inch sub-sample was measured from the outermost live terminal bud inward. Within each sub-sample, the total number of lateral branch shoots were counted and the presence or absence of at least one HWA recorded for each branch shoot. An estimate was then made of HWA densities using the following three categories: Low (1-5); Moderate (6-10); and High (>10 HWA per branch shoot). For each tree, the results of the four branch samples were averaged and the ratio of infested shoots and the relative density of HWA were determined. The post-treatment survey conducted in October, 1996, used the same methodology.

RESULTS

Table 1 shows the results of the pre- and post-treatment surveys for each sample tree. Figure 1 shows the location and assigned numbers of all the hemlock trees in the National Cemetery. Overall, the treatment reduced the level of infested branch shoots by an average of 21.6 percent. Trees 15, 21 and 23 had minor increases which ranged from 4-15 percent. In all cases, the relative density of HWA on the observed shoots was either lowered or unchanged. Only tree numbers 20 and 21 have a post-treatment relative density rating above a low level (1-5 adelgids per branch shoot).

DISCUSSION AND RECOMMENDATIONS

Current populations of HWA in the National Cemetery are at relatively low levels. Excluding trees 20 and 21, the number of infested lateral shoots/tree averaged less than 30 percent and the relative densities of HWA per shoot was observed to be low (1-5 adelgids/shoot). Trees 20 and 21 have a higher level of infestation, averaging 39 and 52 percent infested shoots respectively, and a moderate level (6-10) of adelgids per shoot.

The treatment conducted last April provided a disappointing level of population reduction overall (21.6 percent) but nevertheless suppressed a rapidly building population. That's the good news. The bad news is that the existing population is still sufficient to increase rapidly and damage to the hemlocks could become apparent by the fall of 1997.

To protect these trees, we recommend the infested trees be treated again. A two percent solution of horticultural oil should be applied as soon as possible and a follow-up treatment this spring in April at the first sign of crawler activity. The spring treatment, if needed, should use a 1 percent solution of horticultural oil to avoid any risk of phytotoxicity to the foliage.

Figure 1. Location of Hemlock Trees at the National Cemetary, Gettysburg National Military Park.

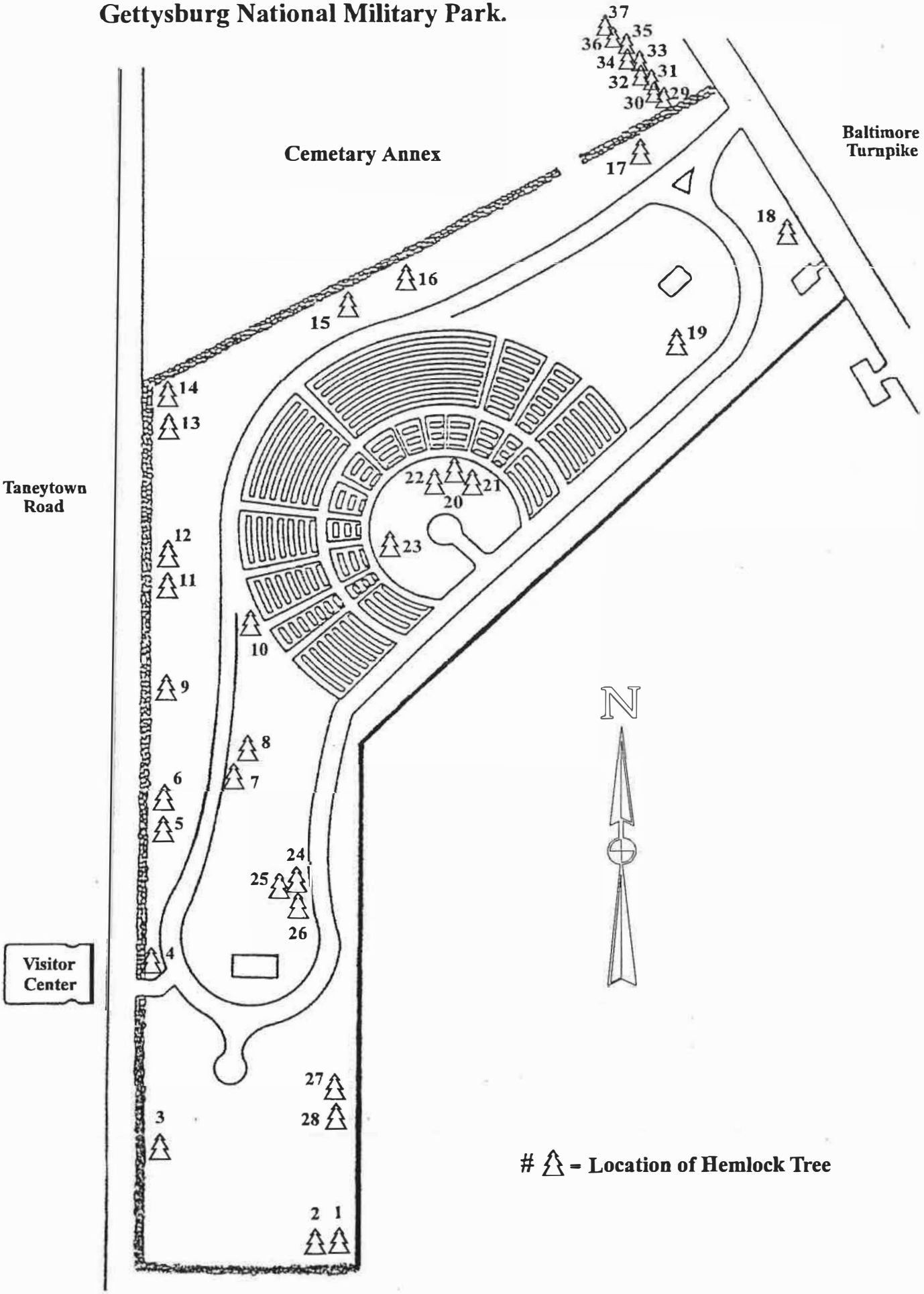

Table 1.--Monitoring results of HWA populations (pre- and post-treatment) at the National Cemetery, Gettsyburg National Military Park - 1996.

Tree #	Pre-treatment (2/28/96) % shoots with HWA	Relative Density of HWA/shoot*	Post-treatment (10/25/96) % shoots with HWA	Relative Density of HWA/shoot*	% Change of Infested Shoots
7	41%	Low	16%	Low	-25%
8	43%	Low	1%	Low	-42%
9	68%	High	1%	Low	-67%
11	5%	Low	0	--	- 5%
12	63%	High	24%	Low	-39%
14	20%	Low	2%	Low	-18%
15	2%	Low	7%	Low	+ 5%
20	61%	Moderate	39%	Moderate	-21%
21	37%	Moderate	52%	Moderate	+15%
22	61%	High	18%	Low	-43%
23	22%	Low	26%	Low	+ 4%
	Average: 38.5%		Average: 16.9%		Average: -21.6%

*Subjective density estimate of the number of HWA nymphs per lateral shoot.

Low: 1-5 adelgids/lateral shoot
Moderate: 6-10 adelgids/lateral shoot
High >10 adelgids/lateral shoot

We may never eradicate the HWA from the Cemetery, but we can reduce the population to a non-threatening level. To this end, continued monitoring is critical.

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